US009435066B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.: US 9,435,066 B2**
(45) **Date of Patent: Sep. 6, 2016**

(54) **WATER SUPPLY APPARATUS AND WASHING MACHINE HAVING THE SAME**

(75) Inventors: **Song Yik Lee**, Suwon-si (KR); **Dong Il Back**, Hwaseong-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-Si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 813 days.

(21) Appl. No.: **13/591,711**

(22) Filed: **Aug. 22, 2012**

(65) **Prior Publication Data**

US 2013/0047678 A1 Feb. 28, 2013

(30) **Foreign Application Priority Data**

Aug. 26, 2011 (KR) 10-2011-0086079

(51) **Int. Cl.**
D06F 39/02 (2006.01)

(52) **U.S. Cl.**
CPC ***D06F 39/028*** (2013.01)

(58) **Field of Classification Search**
CPC D06F 39/028
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0188729 A1 9/2005 Zsambeki et al.

FOREIGN PATENT DOCUMENTS

EP	0 504 545	1/1992
EP	1 541 740	12/2003
EP	1 568 815	2/2004
GB	2 104 109	7/1982
GB	2 271 783	4/1994

OTHER PUBLICATIONS

European Search Report issued Oct. 29, 2013 in corresponding European Application No. 12 18 1030.

Primary Examiner — Jason Ko
(74) *Attorney, Agent, or Firm* — Staas & Halsey LLP

(57) **ABSTRACT**

Disclosed is a water supply apparatus for washing machines having a simplified structure. The water supply apparatus is usable in a washing machine, which has a drum to accommodate laundry, and a detergent supply apparatus including a dispenser provided with a plurality of channels to supply water to a plurality of detergents to be supplied to the drum, and includes at least one water supply pipe extending from the rear portion of the washing machine to the detergent supply apparatus to supply water to the dispenser, a nozzle provided with one end connected to the at least one water supply pipe and the other end disposed adjacent to entrances of the plurality of channels, and being rotatable to supply water selectively to one of the plurality of channels, a drive unit generating drive force to rotate the nozzle, and a rotation control device to control rotation of the drive unit.

15 Claims, 13 Drawing Sheets

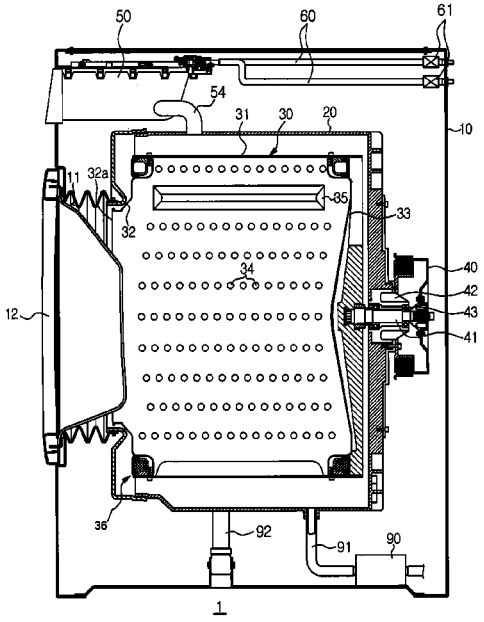


FIG. 1

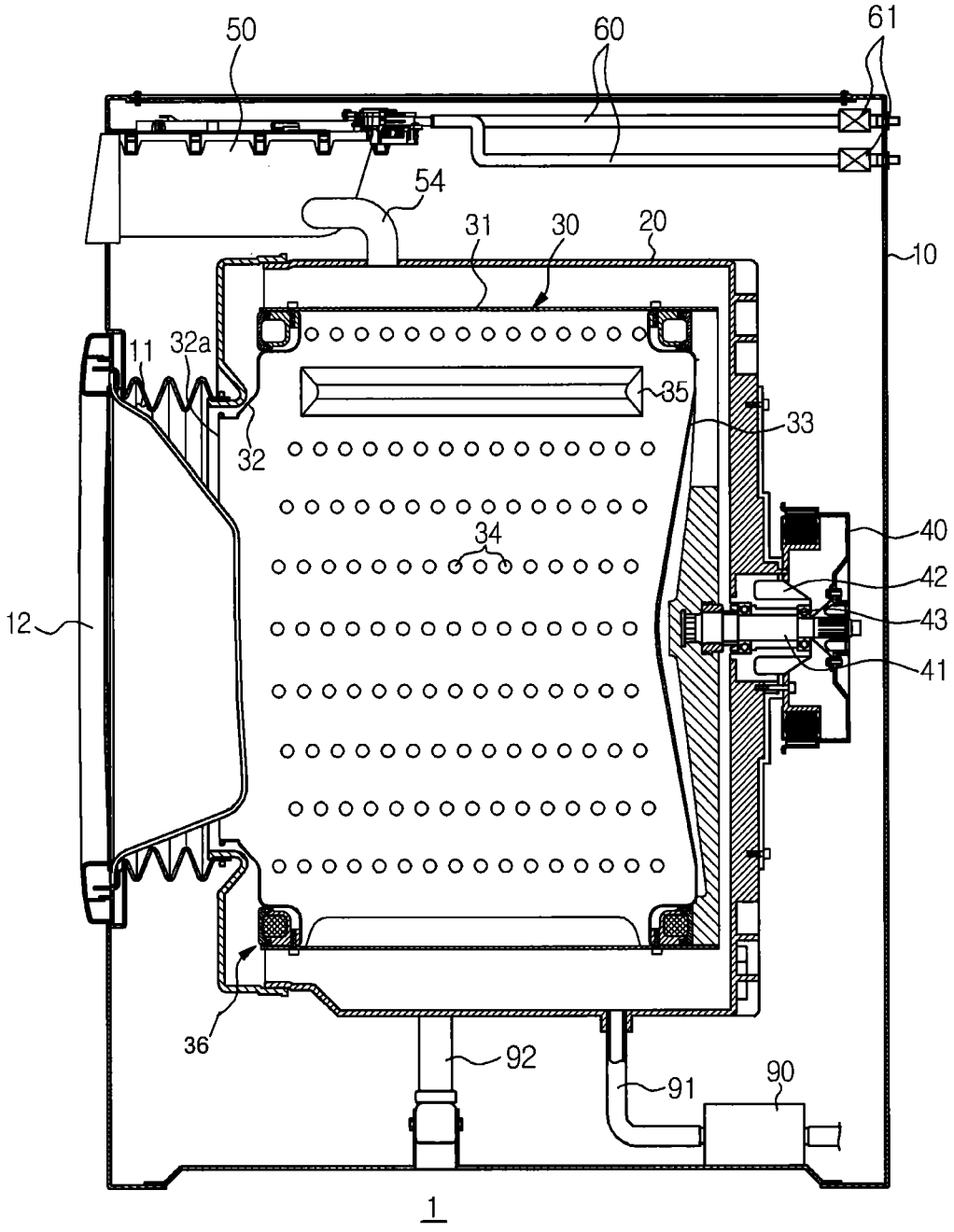


FIG. 2

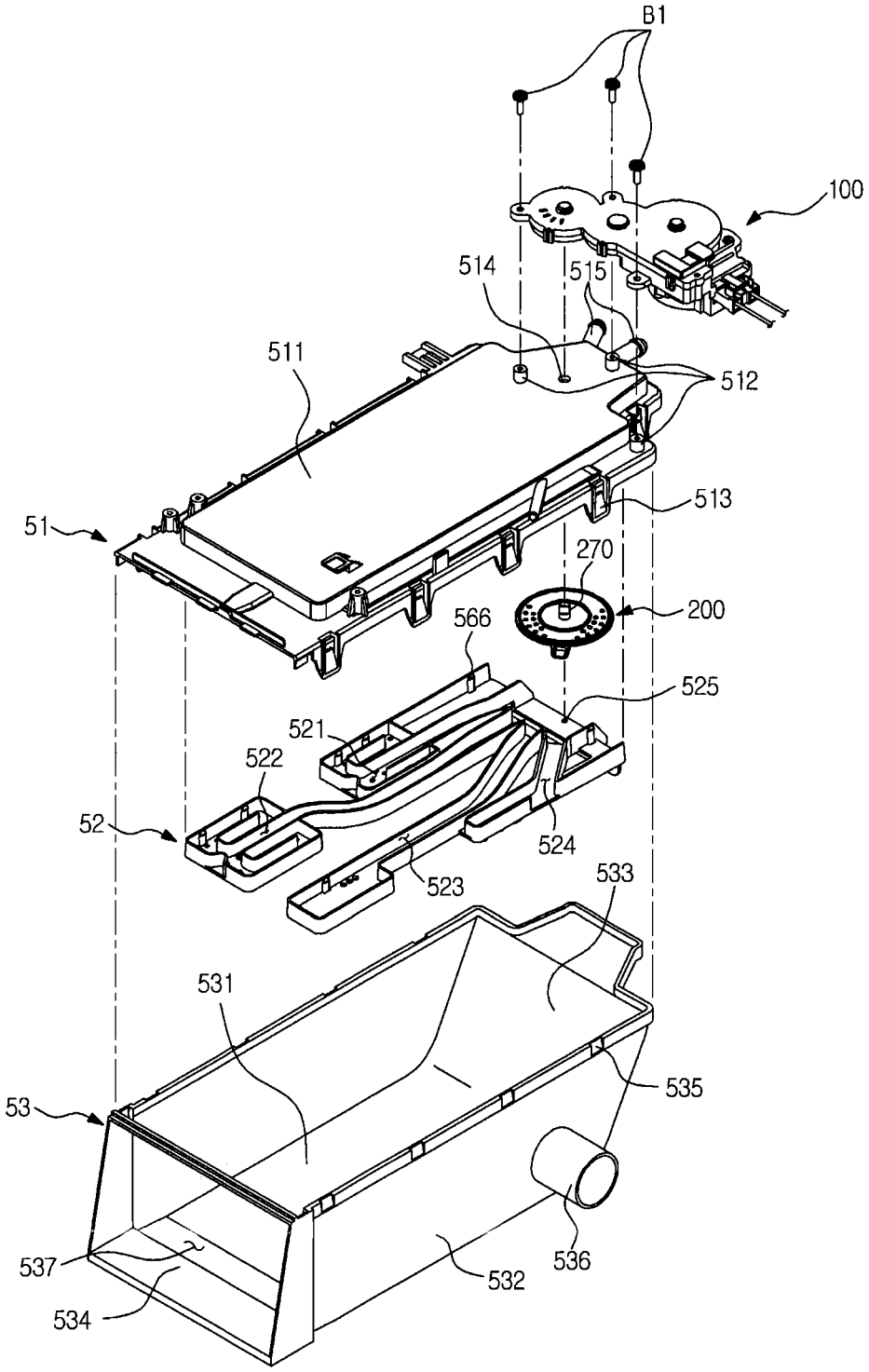

B1
100
514
515
511
512
513
51
270
200
566
525
521
522
52
524
523
533
531
535
53
537
534
532
536

FIG. 3

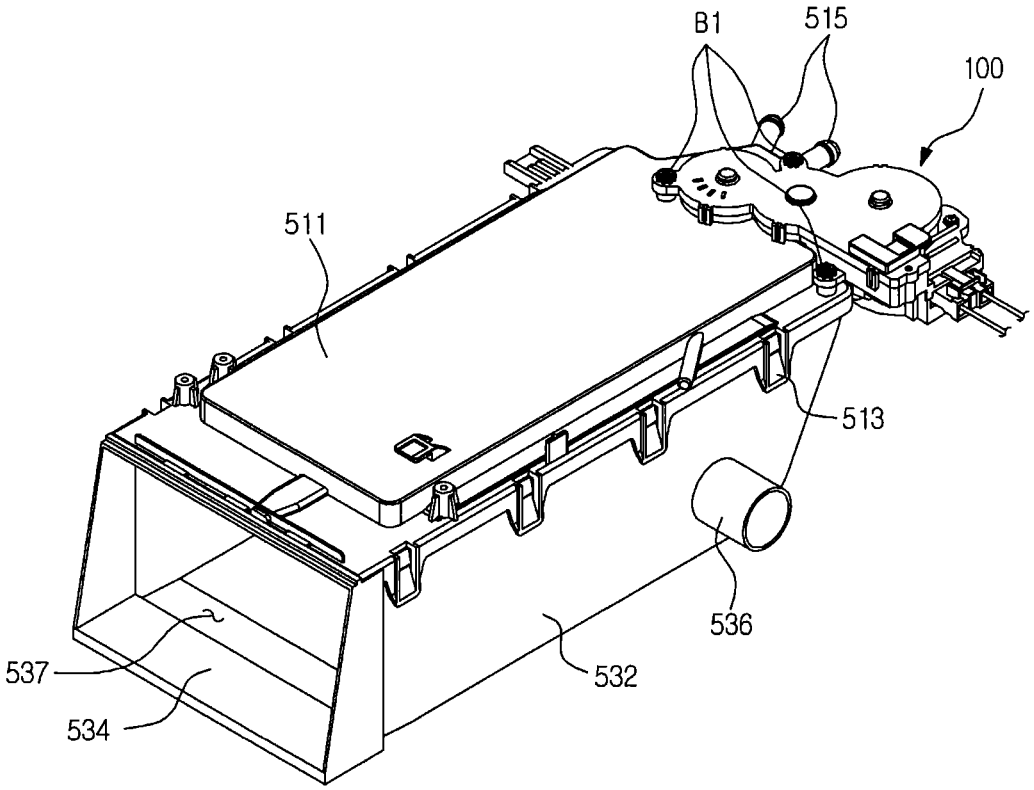


FIG. 4

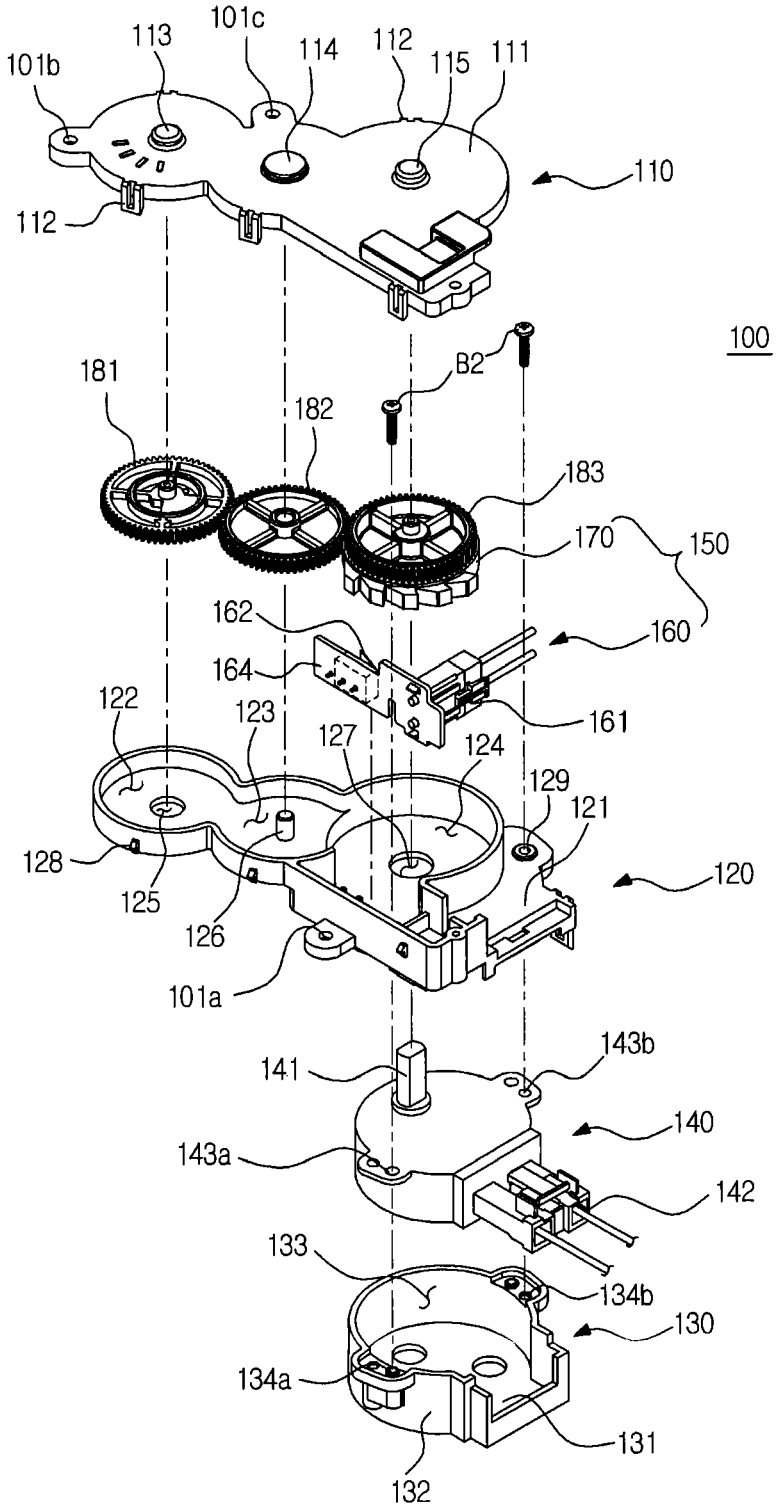

101c
113
114
112
115
111
101b
110
112
100
B2
181
182
183
170
150
162
160
164
161
122
123
127
124
129
121
128
120
125
126
101a
143b
141
140
143a
142
133
134b
130
134a
131
132

FIG. 5

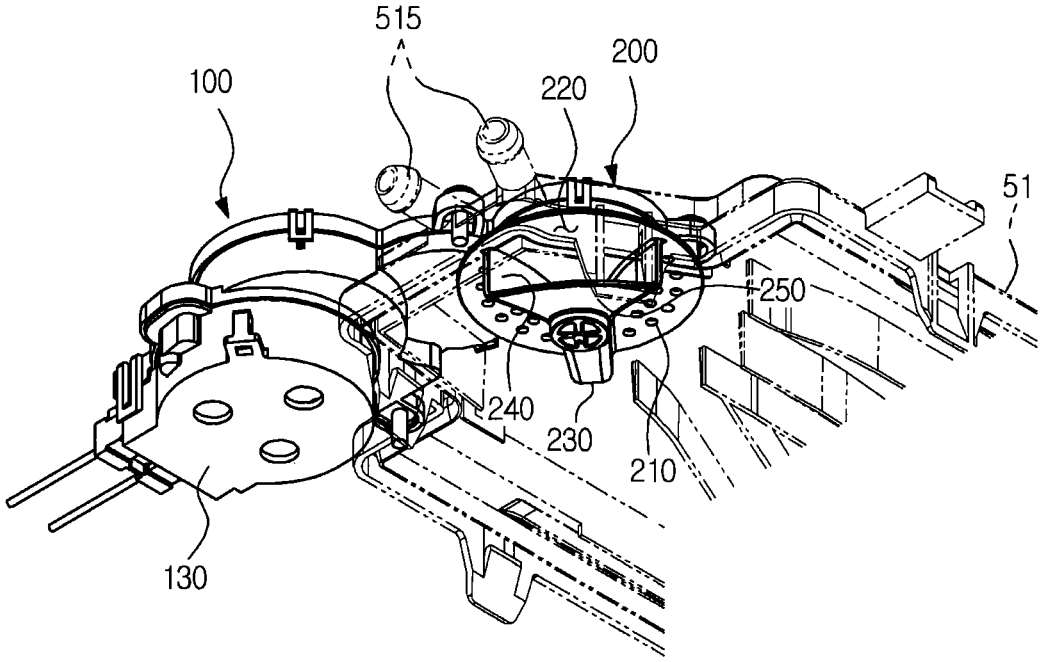


FIG. 6A

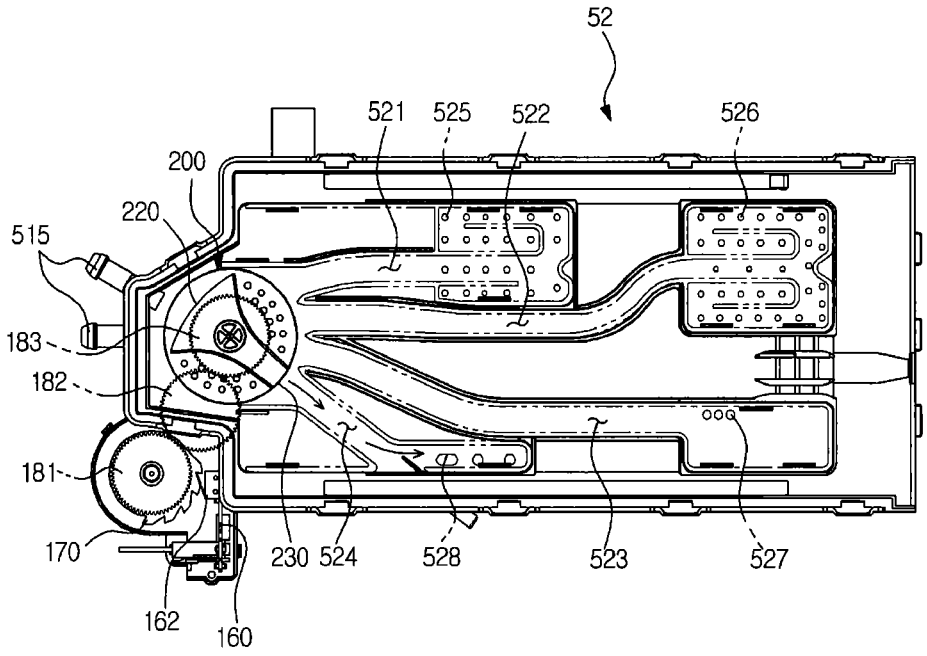

52
521
525
522
526
200
220
515
183
182
181
170
230
524
528
523
527
162
160

FIG. 6B

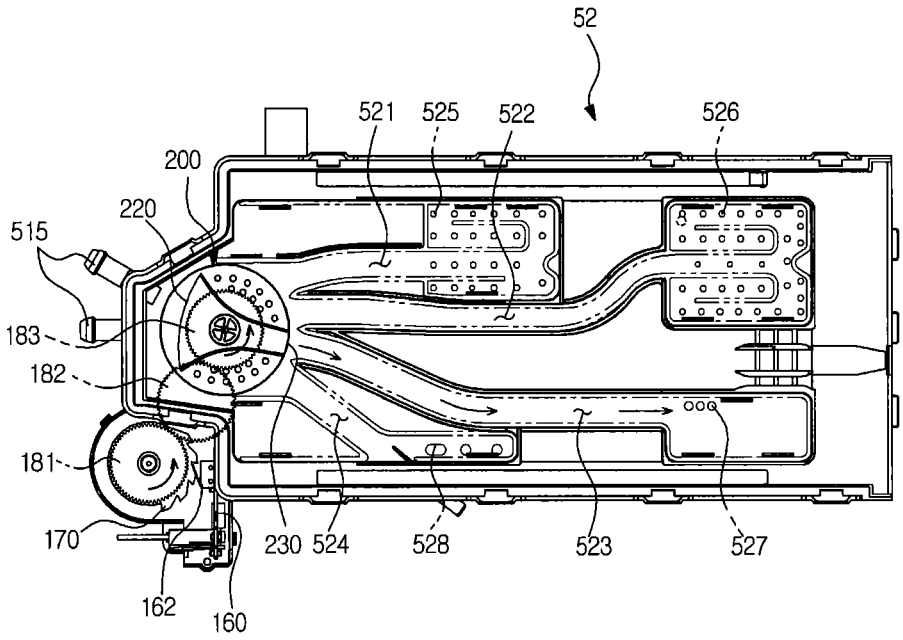

52
521
525
522
526
200
220
515
183
182
181
170
230
524
528
523
527
162
160

FIG. 7A

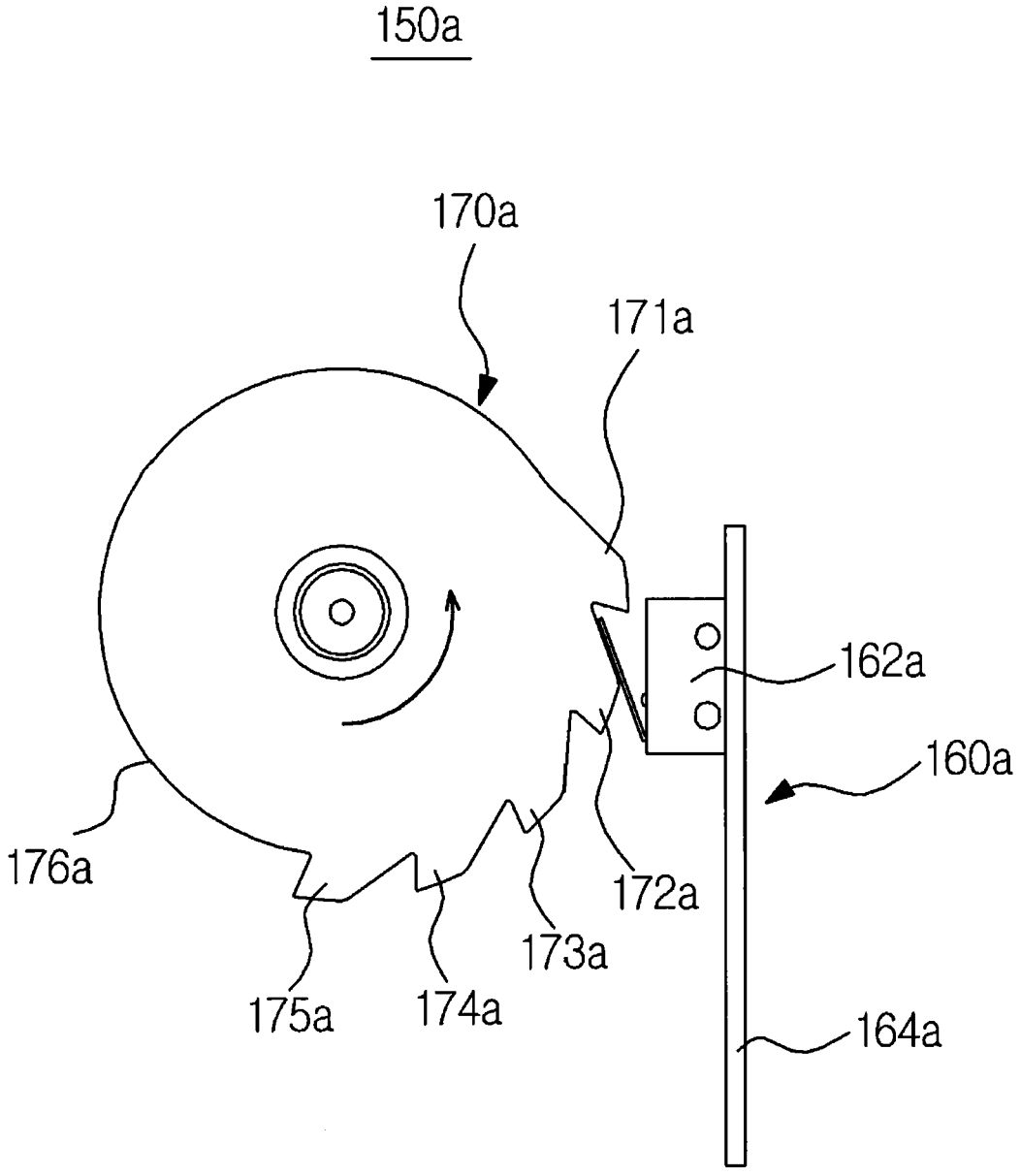


FIG. 7B

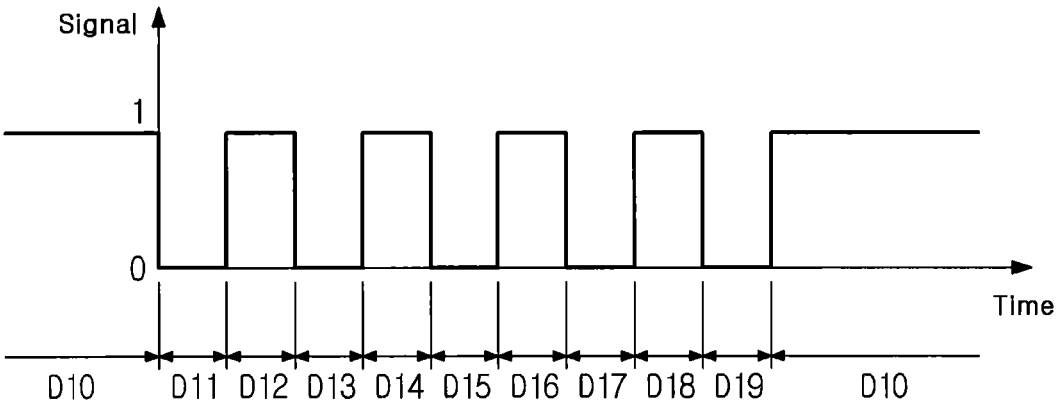


FIG. 8A

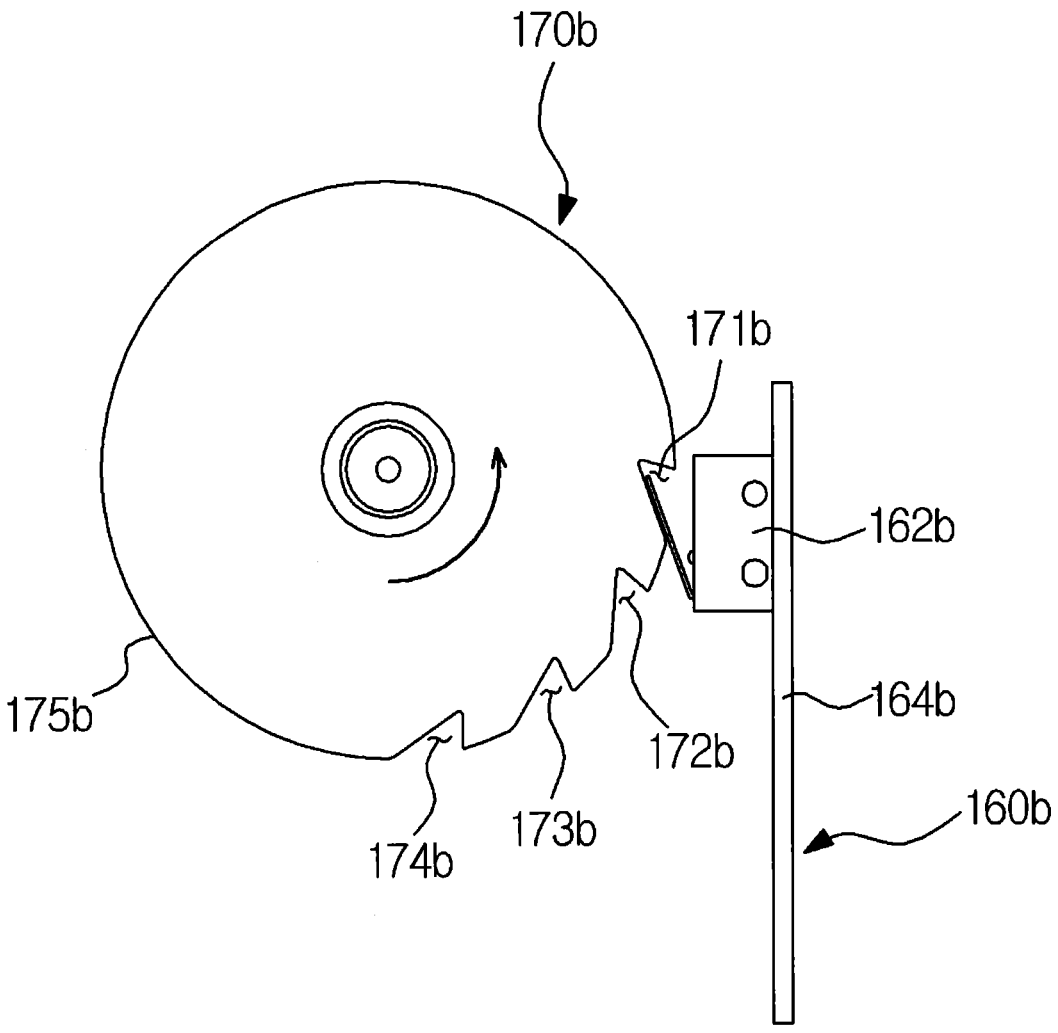


FIG. 8B

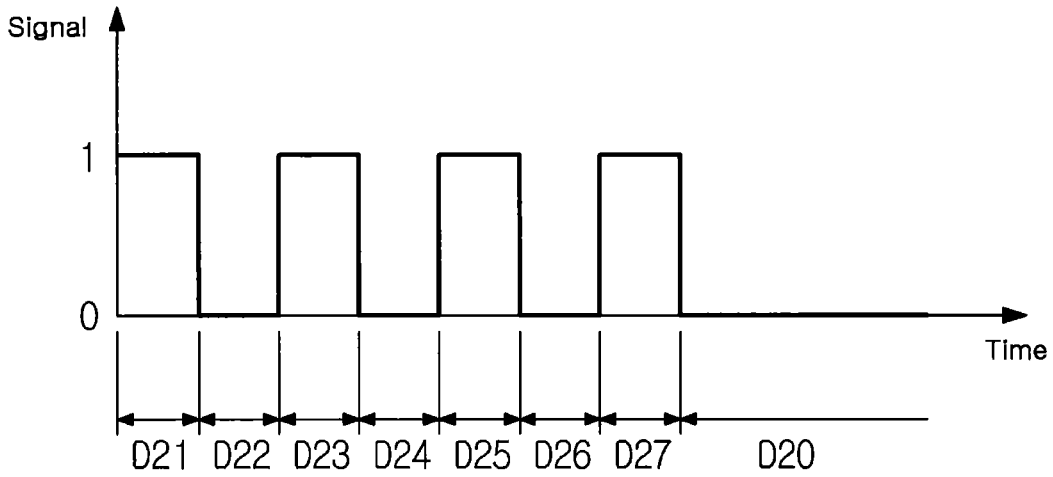


FIG. 9A

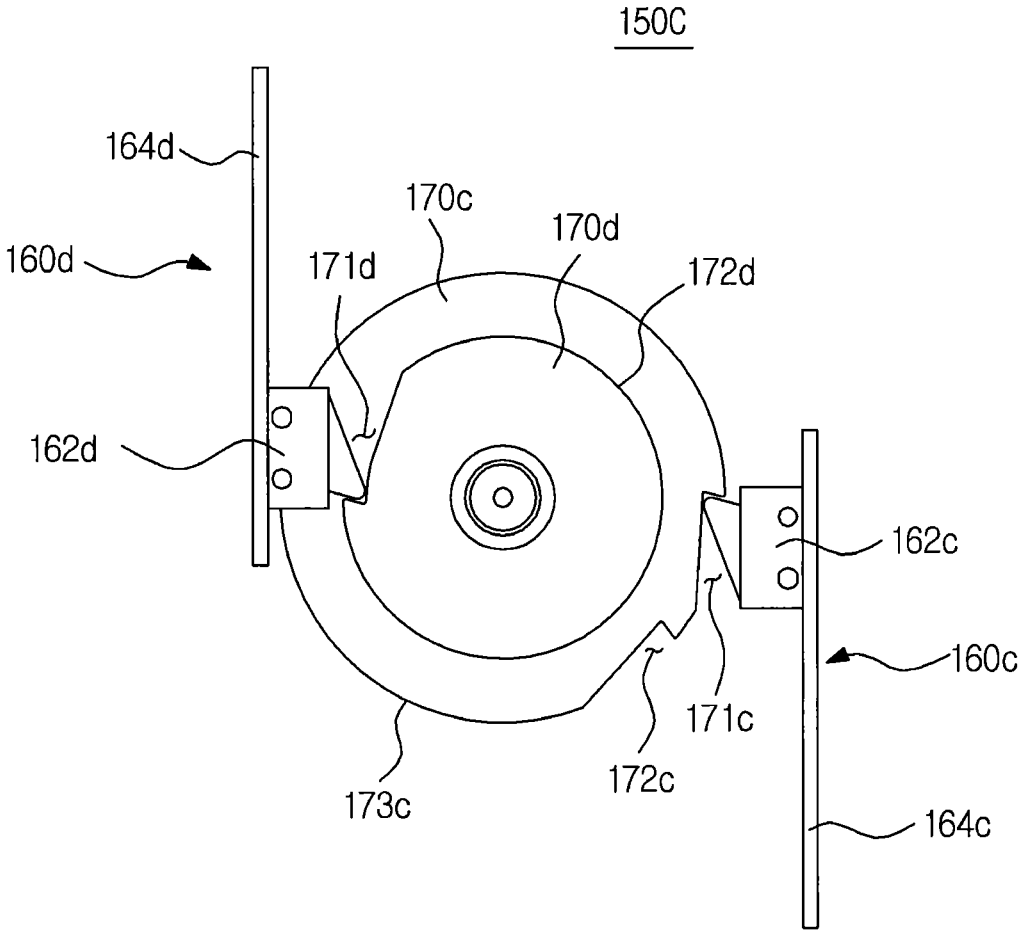
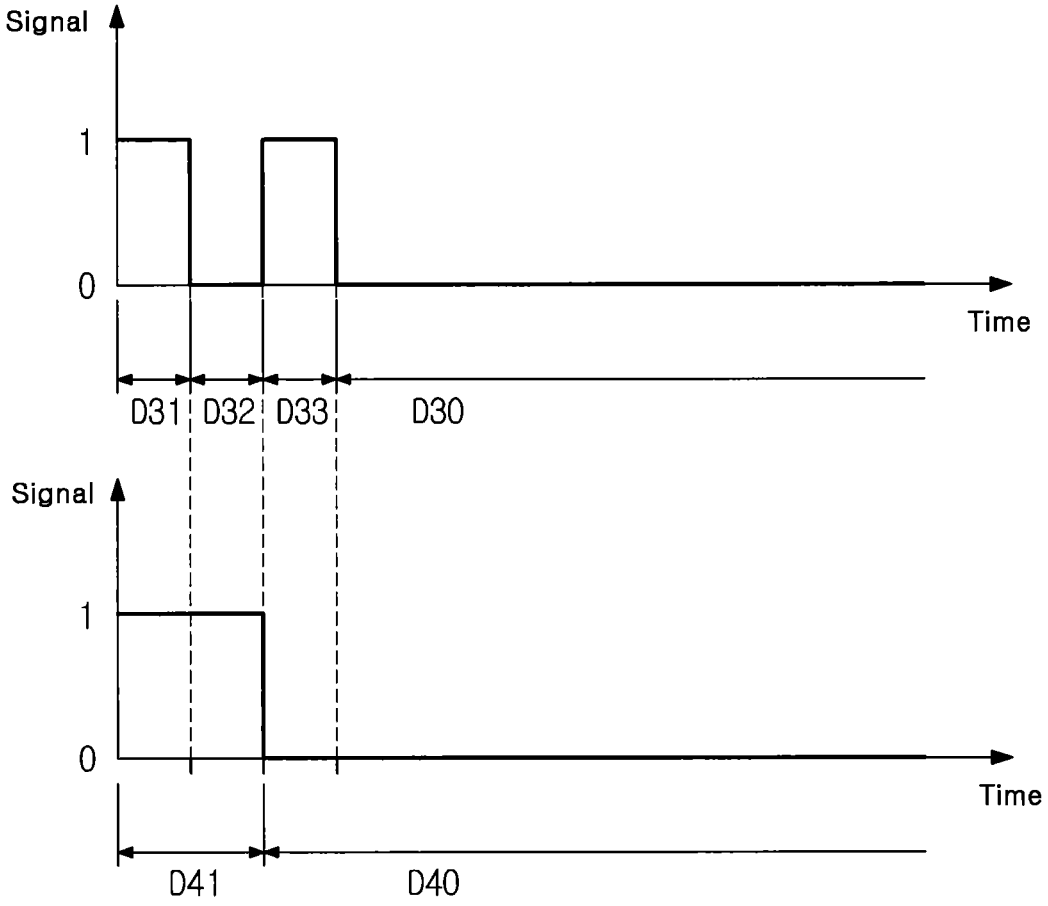

150C
164d
160d
170c
170d
171d
172d
162d
162c
160c
171c
172c
173c
164c

FIG. 9B



WATER SUPPLY APPARATUS AND WASHING MACHINE HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Patent Application No. 10-2011-0086079, filed on Aug. 26, 2011 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field

Embodiments of the present invention relate to a water supply apparatus for washing machines which supplies water to a detergent supply apparatus.

2. Description of the Related Art

A washing machine is machinery which washes laundry using electric power, and includes a tub to store wash water, a drum rotatably installed within the tub, and a motor to rotate the drum.

When the drum is rotated by the motor under the condition that laundry and wash water are placed within the drum, the laundry is washed due to friction of the laundry with the drum and the wash water.

A detergent supply apparatus of the washing machine serves to uniformly mix wash water supplied to the tub with detergents so as to supply the wash water mixed with the detergents to the tub.

The detergent supply apparatus includes a dispenser having a plurality of channels to supply water to the respective detergents, i.e., a main detergent, a fabric softer, a bleaching agent, etc.

In order to supply water to the respective channels, a solenoid valve needs to be connected to the detergent supply apparatus by a plurality of rubber hoses, the detergent supply apparatus has a complicated structure and a large size. Further, since the solenoid valve is used, resonance noise is generated.

SUMMARY

Therefore, it is an aspect of the present disclosure to provide a water supply apparatus having a simple structure for washing machines which supplies water to a detergent supply apparatus.

Additional aspects will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

In accordance with one aspect, a water supply apparatus usable in a washing machine, which has a drum to accommodate laundry and a detergent supply apparatus including a dispenser provided with a plurality of channels to supply water to a plurality of detergents to be supplied to the drum. The washing machine includes at least one water supply pipe extending from the rear portion of the washing machine to the detergent supply apparatus to supply water to the dispenser, a nozzle provided with one end connected to the at least one water supply pipe and the other end disposed adjacent to entrances of the plurality of channels, and being rotatable to supply water selectively to one of the plurality of channels, a drive unit generating drive force to rotate the nozzle, and a rotation control device to control rotation of the drive unit.

The nozzle may include an inlet provided adjacent to the at least one water supply pipe such that water is introduced into the nozzle through the inlet, and an outlet to supply water to one of the plurality of channels.

The nozzle inlet may have an area sufficient to cover one end of the at least one water supply pipe so as to allow water supplied from the at least one water supply pipe to be introduced into the nozzle through the inlet.

The nozzle outlet may have a smaller area than the entrances of the plurality of channels to supply water to one of the plurality of channels.

The nozzle inlet may have a greater area than the outlet.

The nozzle may include nozzle side walls forming both side surfaces of the inlet and the outlet, and the nozzle side walls may be formed in a curved line from the inlet to the outlet.

The drive unit may include a motor.

The drive unit may further include a plurality of gears disposed between the motor and the nozzle to transmit drive force of the motor to the nozzle.

The plurality of gears may include a first gear connected to the nozzle and rotated together with the nozzle, and a second gear connected to the motor and rotated by drive force of the motor.

The nozzle may be rotatably accommodated in the detergent supply apparatus, and the drive unit may be disposed on the upper surface of the detergent supply apparatus.

The rotation control device may include a cam connected to the drive unit to be rotated together with the drive unit and including at least one protruding rib protruding in the centrifugal direction, and a switch disposed to contact the cam and locked with and unlocked from the at least one protruding rib to generate an ON signal and an OFF signal when the cam is rotated.

The rotation control device may include a cam connected to the drive unit to be rotated together with the drive unit and including at least one groove disposed in the radial direction, and a switch disposed to contact the cam and locked with and unlocked from the at least one groove to generate an ON signal and an OFF signal when the cam is rotated.

In accordance with another aspect, a water supply apparatus usable in a washing machine, which has a drum to accommodate laundry and a detergent supply apparatus to supply detergents to wash water supplied to the drum, includes at least one water supply pipe extending from the rear portion of the washing machine to the detergent supply apparatus to supply water to the detergent supply apparatus, and a nozzle provided with one end connected to the at least one water supply pipe and the other end disposed to supply water to the detergent supply apparatus, and being rotatable to supply water in a designated direction within the detergent supply apparatus.

The detergent supply apparatus may include a dispenser provided with a plurality of channels to respectively supply water to a plurality of detergents, and the nozzle is rotatable to respectively supply water to the plurality of channels.

The detergent supply apparatus may further include a detergent case forming the external appearance of the detergent supply apparatus and accommodating the dispenser, and the nozzle may be rotatably fixed within the detergent case.

The water supply apparatus may further include a drive unit connected to the nozzle to rotate the nozzle.

The water supply apparatus may further include a rotation control device to control rotation of the drive unit to stop the nozzle in a designated direction to supply water.

In accordance with another aspect, a washing machine includes a cabinet, a tub disposed within the cabinet to store water, a drum disposed within the tub to accommodate

laundry, a detergent supply apparatus including a plurality of detergent containers to accommodate a plurality of detergent containers supplied to the drum and provided above the tub, water supply pipes to transmit water supplied from a water supply source provided at the rear of the cabinet to the detergent supply apparatus, and a nozzle rotated to respectively supply water to the plurality of detergent containers, wherein the nozzle is connected to the water supply pipes and installed within the detergent supply apparatus.

The washing machine may further include a drive unit to rotate the nozzle.

The drive unit may include a motor to generate rotary force and at least one gear to transmit rotary force of the motor to the nozzle.

The drive unit may further include a rotation control device to control rotation of the motor.

In accordance with a further aspect, a washing machine includes a cabinet, a tub disposed within the cabinet to store water, a drum disposed within the tub to accommodate laundry, a detergent supply apparatus including a dispenser provided with a plurality of channels to supply detergents to the drum, a nozzle moving within the detergent supply apparatus to respectively supply water to the plurality of channels, a drive unit to move the nozzle within the detergent supply apparatus, and a control device to control movement of the nozzle.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. **1** is a cross-sectional view of a washing machine in accordance with one embodiment of the present invention;

FIG. **2** is an exploded perspective view illustrating respective components of a detergent supply apparatus and a water supply apparatus of the washing machine in accordance with the embodiment of the present invention;

FIG. **3** is a perspective view illustrating connection of the respective components of FIG. **2**;

FIG. **4** is an exploded perspective view illustrating respective components of a drive unit of FIG. **2**;

FIG. **5** is a perspective view illustrating the water supply apparatus of the washing machine in accordance with the embodiment of the present invention;

FIGS. **6**A and **6**B are views illustrating operation of the water supply apparatus of the washing machine;

FIG. **7**A is a view illustrating a rotation control device of a washing machine in accordance with one embodiment of the present invention;

FIG. **7**B illustrates a graph representing signals transmitted by a switch of the rotation control device of FIG. **7**A;

FIG. **8**A is a view illustrating a rotation control device of a washing machine in accordance with another embodiment of the present invention;

FIG. **8**B illustrates a graph representing signals transmitted by a switch of the rotation control device of FIG. **8**A; and

FIG. **9**A is a view illustrating a rotation control device of a washing machine in accordance with a further embodiment of the present invention; and

FIG. **9**B illustrates graphs representing signals transmitted by switches of the rotation control device of FIG. **9**A.

DETAILED DESCRIPTION

Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

FIG. **1** is a cross-sectional view of a washing machine in accordance with one embodiment of the present invention.

As shown in FIG. **1**, a washing machine **1** in accordance with this embodiment includes a cabinet **10** forming the external appearance of the washing machine **1**, a tub **20** disposed within the cabinet **10**, a drum **30** rotatably disposed within the tub **20**, and a motor **40** to drive the drum **30**.

An inlet **11** through which laundry is put into the drum **20** is formed on the front surface of the cabinet **10**. The inlet **11** is opened and closed by a door **12** installed on the front surface of the cabinet **10**.

The tub **20** is supported by a damper **92**. The damper **92** is connected to the inner lower surface of the cabinet **10** and to the outer surface of the tub **20**.

A drain pump **90** and a drain pipe **91** to discharge water in the tub **20** to the outside of the cabinet **10** are installed under the tub **20**.

The drum **30** includes a cylindrical member **31**, a front plate **32** disposed at the front portion of the cylindrical member **31**, and a rear plate **33** disposed at the rear portion of the cylindrical member **31**. An opening **32***a* through which laundry is put into and taken out of the drum **30** is formed through the front plate **32**, and a drive shaft **41** to transmit power of the motor **40** is connected to the rear plate **33**.

A plurality of through holes **34** to circulate wash water is provided on the circumference of the drum **30**, and the inner space of the drum **30** and the inner space of the tub **20** communicate with each other by the through holes **34**.

A plurality of lifters **35** to tumble laundry when the drum **30** is rotated is installed on the inner circumferential surface of the drum **30**.

The drive shaft **41** is disposed between the drum **30** and the motor **40**. One end of the drive shaft **41** is connected to the rear plate **33** of the drum **30**, and the other end of the drive shaft **41** extends to the outside of the rear wall of the tub **20**. When the motor **40** drives the drive shaft **41**, the drum **30** connected to the drive shaft **41** is rotated about the drive shaft **41**.

A bearing housing **42** to rotatably support the drive shaft **41** is installed on the rear wall of the tub **20**. The bearing housing **42** may be formed an aluminum alloy, and be inserted into the rear wall of the tub **20** when the tub **20** is produced through injection molding. Bearings **43** to facilitate rotation of the drive shaft **41** are installed between the bearing housing **42** and the drive shaft **41**.

During a washing cycle, the motor **40** rotates the drum **30** at a low velocity in a regular direction and in the reverse direction, and thereby tumbling of the laundry within the drum **30** is repeated, thus removing contaminants from the laundry.

During a spin-drying cycle, when the motor **40** rotates the drum at a high velocity in one direction, water is separated from the laundry by centrifugal force applied to the laundry.

When the laundry is not uniformly distributed within the drum **30** and is concentrated into a specific region during rotation of the drum **30** in the spin-drying process, unbalanced load occurs within the drum **30**, and thus rotation of the drum **30** becomes instable and vibration and noise occur.

Therefore, the washing machine **1** is provided with balancers **36** to stabilize rotation of the drum **30**. Here, a pair of balancers **36** is formed on the front plate **32** and the rear plate **33** of the drum **30**.

Water supply pipes **60** to supply wash water to the tub **20** are installed above the tub **20**. One end of each of the water

supply pipes **60** is connected to an external water supply source (not shown), and the other end of each of the water supply pipes **60** is connected to a detergent supply apparatus **50**.

The detergent supply apparatus **50** is connected to the tub **20** through a connection pipe **54**. Water supplied through the water supply pipe **60** is supplied to the detergent supply apparatus **52** and is mixed with detergents in the detergent supply apparatus **52**, and the water mixed with the detergents is supplied to the inside of the tub **20**.

FIG. **2** is an exploded perspective view illustrating respective components of the detergent supply apparatus and a water supply apparatus of the washing machine in accordance with the embodiment of the present invention, and FIG. **3** is a perspective view illustrating connection of the respective components of FIG. **2**.

As shown in FIGS. **2** and **3**, the detergent supply apparatus **50** includes a detergent case **53** forming the external appearance of the detergent supply apparatus **50**, a detergent case cover **51** disposed to cover the upper portion of the detergent case **53**, and a dispenser **52** disposed between the detergent case **53** and the detergent case cover **51**.

The water supply apparatus includes a nozzle **200** rotatably disposed between the detergent case cover **51** and the dispenser **52**, and a drive unit **100** to supply drive force to rotate the nozzle **200**.

The detergent case **53** includes a bottom surface **531**, side walls **532** protruding upwards from the bottom surface **531** to form both side surfaces of the detergent case **53**, and a rear plate **533** bent upwards from the bottom surface **531** in a gentle curved line to form a rear surface of the detergent case **53**.

A plurality of first accommodation parts **535** to accommodate first connection parts **531** of the detergent case cover **51**, which will be described later, to connect the detergent case cover **51** to the detergent case **53** is formed on the side walls **532**. The embodiment illustrated in the drawings describes eight first accommodation parts **535**.

A front frame **534** provided with an opening **537** is located at the front surface of the detergent case **53**, and is connected to the bottom surface **531** and the side walls **532**. Detergent containers (not shown) accommodating detergents are accommodated in the opening **537**.

The upper surface of the detergent case **53** is opened.

The detergent case cover **51** covers the opened upper surface of the detergent case **53**, thus forming the external appearance of the detergent supply apparatus **50** together with the detergent case **53**. Although the embodiment illustrated in the drawings describes the detergent case cover **51** as having a central portion protruding upwards to form a **2**-step structure, the detergent case cover **51** may have other multi-step structures.

Three first connection recesses **512** are formed on an upper plate **511** of the detergent case cover **51** so as to connect the drive unit **100** to the upper plate **511**. First connection holes **101***a*, **101***b* and **101***c* are formed at positions of the drive unit **100** corresponding to the first connection recesses **512**. When bolts B**1** pass through the first connection holes **101***a*, **101***b* and **101***c* and are fastened to the first connection recesses **512**, the drive unit **100** is connected to the upper plate **511** of the detergent case cove **51**. The drive unit **100** will be described later with reference to FIG. **4**.

Connection pipes **515** to which the water supply pipes **60** (with reference to FIG. **1**) are connected protrude from the rear portion of the detergent case cover **51**. FIGS. **2** and **3** illustrate two connection pipes **515** to which a warm water supply pipe and a cold water supply pipe are respectively connected.

The dispenser **52** includes plural channels **521**, **522**, **523** and **524**, and the plural channels **521**, **522**, **523** and **524** form the external appearance of the dispenser **52**. The detergent containers (not shown) accommodate a main detergent, a fabric rinse, a bleaching agent, etc., and in order to separately supply water thereto, the plural channels **521**, **522**, **523** and **524** are formed.

The dispenser **52** includes second connection parts **566**, and is connected to the detergent case cover **51** by fastening the second connection parts **566** to connection recesses (not shown) of the detergent case cover **51**.

A second accommodation hole **525** in which one end of a shaft **270** of the nozzle **200** is accommodated is formed at the rear portion of the dispenser **52**. Further, a first accommodation hole **514** in which the other end of the shaft **270** of the nozzle **200** is accommodated is formed at a portion of the upper plate **511** of the detergent case cover **51** corresponding to the second accommodation hole **525**.

The nozzle **200** is disposed between the dispenser **52** and the detergent case cover **51** under the condition that one end of the shaft **270** is accommodated in the second accommodation hole **525** and the other end of the shaft **270** is accommodated in the first accommodation hole **514**. When the dispenser **52** is connected to the detergent case cover **51**, the nozzle **200** is located between the dispenser **52** and the detergent case cover **51** so as to be rotated about the shaft **270**.

First connection parts **513** are formed at positions of the side surfaces of the detergent case cover **51** corresponding to the first accommodation parts **535**. FIGS. **2** and **3** illustrate eight first connection parts **513** corresponding to the number of the first accommodation parts **535**. The first connection parts **513** protrude the side surfaces of the detergent case cover **51** in the direction towards the detergent case **53**, and the ends of the first connection parts **513** protrude inwards to be fixed to the first accommodation parts **535**.

Therefore, when the protruding ends of the first connection parts **513** are accommodated in the first accommodation parts **535**, the detergent case cover **51** is connected to the detergent case **53**.

FIG. **4** is an exploded perspective view illustrating respective components of the drive unit of FIG. **2**.

As shown in FIG. **4**, the drive unit **100** includes a motor **140** to generate drive force, a motor case **130** to accommodate the motor **140**, plural gears **181**, **182** and **183** to transmit drive force of the motor to the nozzle **20** (with reference to FIG. **2**), a gear case **120** to accommodate the plural gears **181**, **182** and **183**, a gear cover **110** connected to the gear case **120** to cover the plural gears **181**, **182** and **183**, and a rotation control device **150** to control rotation of the motor **140**.

The rotation control device **150** includes a cam **170**, and a printed circuit board (PCB) assembly **160** sensing a degree of rotation of the cam **170** to control the motor **140**. The rotation control device **150** will be described later with reference to FIG. **6**.

The gear case **120** includes a case main body **121** forming the external appearance of the gear case **120**, gear accommodation parts **122**, **123** and **124** protruding upwards from the case main body **121** to accommodate the plural gears **181**, **182** and **183**, and a PCB accommodation part **165** protruding upwards from the case main body **121** to accommodate the PCB assembly **150**.

The plural gears **181**, **183** and **183** include a first gear **181**, a second gear **183** and a third gear **182**. Although the embodiment illustrated in the drawings describes three gears, more or less than three gears may be provided. However, three or four gears may be provided in consideration of the sizes of the gears and the size of the water supply apparatus.

The first gear **181** includes its own shaft and is accommodated in the first gear accommodation part **122** of the gear case **120**. The first gear accommodation part **122** is provided with a first shaft accommodation hole **125** to accommodate the shaft of the first gear **181**. The first gear **181** is connected to the nozzle **200** (with reference to FIG. **2**) through the shaft, thus being rotated together with the nozzle **200**.

The second gear **183** includes its own shaft and is accommodated in the second gear accommodation part **124** of the gear case **120**. The second gear accommodation part **124** is provided with a second shaft accommodation hole **127** to accommodate the shaft of the second gear **183**. The second gear **183** is connected to the cam **170** through the shaft, thus being rotated together with the cam **170**. Further, the second gear **183** and the cam **170** are connected to a shaft **141** of the motor **140** located thereunder, thus being rotated by drive force of the motor **140**.

The third gear **182** includes a hollow formed at the center of rotation thereof and is accommodated in the third gear accommodation part **123** of the gear case **120**. The third gear accommodation part **123** is provided with a protruding rotation shaft **126** which is inserted into the hollow of the third gear **182**. When the rotation shaft **126** is inserted into the hollow of the third gear **182**, the third gear **182** is accommodated in the third gear accommodation part **123**. The third gear **182** is disposed between the first gear **181** and the second gear **183** so as to be engaged with the first gear **181** and the second gear **183**. Therefore, the third gear **182** receives drive force of the motor **140** through the second gear **183**, and transmits the drive force to the first gear **181** and the nozzle **200** (with reference to FIG. **2**).

A first shaft accommodation recess **113** protruding upwards to accommodate the shaft of the first gear **181** and a second shaft accommodation recess **115** protruding upwards to accommodate the shaft of the second gear **183** are formed on the lower surface of the gear cover **110**. Further, a third shaft accommodation recess **114** protruding upwards to accommodate the rotation shaft **126** inserted into the hollow of the third gear **182** is formed on the lower surface of the gear cover **110**.

Connection protrusions **128** connected to the gear cover **110** are formed on the side surface of the gear case **120**. Second fastening parts **112** protruding downwards to accommodate the connection protrusions **128** are formed on the side surface of the gear cover **110**. When the connection protrusions **128** are fastened to the second fastening parts **112**, the gear cover **110** is connected to the gear case **120**.

The motor case **130** and the motor **140** are connected under the gear case **120**.

The motor case **130** includes a bottom surface **131**, and a side surface **132** having the same shape of the motor **140** and protruding upwards from the bottom surface **131**. A load part **133** on which the motor **140** is loaded is formed at the inside of the side surface **132**.

The motor **140** includes a power supply unit **142** connected to one side of the motor **140** to supply power to the motor **140**, the shaft **141** passing through the second shaft accommodation hole **127** and connected to the second gear **183** and the cam **170** to transmit drive force of the motor **140** to the second gear **183** and the cam **170**, and third fastening holes **143***a* and **143***b* to connect the motor **140** to the gear case **120** and the motor case **130**.

Bolts B**2** pass through second connection holes **129** (here, only one second connection hole is illustrated) formed at one side of the gear case **120** and the third fastening holes **143***a* and **143***b* formed on the motor **140** and are fastened to second connection recesses **134***a* and **134***b* formed at one side of the motor case **130**, thereby connecting the gear case **120**, the motor **140** and the motor case **130**.

In order to connect the drive unit **100** to the detergent case cover **51**, as described above, the first fastening holes **101***a*, **101***b* and **101***c* are formed on the drive unit **100**. The embodiment illustrated in the drawings describes three first fastening holes **101***a*, **101***b* and **101***c*, two fastening holes **101***b* and **101***c* are formed at one side of the gear cover **110**, and one fastening hole **101***a* is formed on the gear case **120**.

FIG. **5** is a perspective view illustrating the water supply apparatus of the washing machine in accordance with the embodiment of the present invention.

A description of the above-described drive unit **100** and gear cover **110** will be omitted.

As shown in FIG. **5**, the nozzle **200** includes a nozzle main body **210** connected to the cam **170** (with reference to FIG. **4**) to rotate the nozzle **200**, nozzle side walls **240** protruding downwards from the nozzle main body **210** to form both side surfaces of the nozzle **200**, and a nozzle bottom surface **250** connecting both nozzle side walls **240**. A hollow in which water flows is formed within a space formed by the nozzle side walls **240** and the nozzle bottom surface **250**. An inlet **220** through which water supplied from the water supply pipe **60** (with reference to FIG. **1**) is introduced into the nozzle **200** is formed at one side of the hollow, and an outlet **230** through which water is discharged to the dispenser **52** is formed at the other side of the hollow.

FIGS. **6**A and **6**B are views illustrating operation of the water supply apparatus of the washing machine. Particularly, in order to describe rotating states of the nozzle **200**, FIGS. **6**A and **6**B illustrate the detergent case cover **51** to which the dispenser **52** and the nozzle **200** are connected, as seen from the bottom.

FIG. **6**A illustrates the nozzle **200** which supplies water towards the first channel **524**, and FIG. **6**B illustrates the nozzle **200** which supplies water towards the second channel **523**.

As shown in FIGS. **6**A and **6**B, the cam **170** and the first gear **181** connected to the motor **140** (with reference to FIG. **4**) are rotated in the counterclockwise direction. Although FIGS. **6**A and **6**B illustrate the cam **170** and the first gear **181** as being rotated in the counterclockwise direction, the cam **170** and the first gear **181** are rotated in the clockwise direction, as seen from the top. Further, when arrangement and shapes of the cam **170** and a switch **162** are changed, the cam **170** and the first gear **181** may be rotated in the clockwise direction.

When the cam **170** and the first gear **181** are rotated in the counterclockwise direction, the third gear **182** engaged with the first gear **181** is rotated in the clockwise direction, and the second gear **183** engaged with the third gear **182** is rotated in the counterclockwise direction.

The nozzle **200** first supplies water towards the first channel **524**, as shown in FIG. **6**A, and when the nozzle **200** is rotated, the nozzle **200** supplies water towards the second channel **523**, as shown in FIG. **6**B. Then, the nozzle **200** is rotated in such a manner, thereby supplying water towards the third channel **522** and the fourth channel **521**.

Water supplied to the respective channels **521**, **522**, **523** and **524** is discharged to the detergent case **53** through

discharge holes **525**, **526**, **527** and **528** provided at one end of each of the channels **521**, **522**, **523** and **524**.

Although the nozzle **200** is rotated, both connection pipes **515** may supply water towards the wide inlet **220**. As described above, the warm water supply pipe is connected to one of the two connection pipes **515**, and the cold water supply pipe is connected to the other of the two connection pipes **515**.

Therefore, while the conventional water supply apparatus requires many connection pipes to supply cold water and warm water to all of channels of a dispenser, the water supply apparatus **50** in accordance with the present invention may supply cold water and warm water to all of the plural channels **521**, **522**, **523** and **524** through a simple structure.

FIG. **7**A is a view illustrating a rotation control device of a washing machine in accordance with one embodiment of the present invention, and FIG. **7**B illustrates a graph representing signals transmitted by a switch of the rotation control device of FIG. **7**A.

In order to coincide with the rotating direction of the nozzle in FIGS. **6**A and **6**B, FIG. **7**A illustrates the cam, as seen from the bottom.

As shown in FIG. **7**A, a rotation control device **150***a* includes a cam **170***a* and a PCB assembly **160***a*. The PCB assembly **160***a* includes a PCB **164***a*, and a switch **162***a* mounted on one surface of the PCB **164***a* to contact the cam **170***a*.

The cam **170***a* includes a disc-shaped cam main body **176***a*, and five protruding ribs **171***a*, **172***a*, **173***a*, **174***a* and **175***a*.

The nozzle **200** (with reference to FIG. **2**) is disposed at the lower end of the cam **170***a*, and is rotated together with the cam **170***a*.

The cam **170***a* and the nozzle **200** are disposed such that when the switch **162***a* is located between the first protruding rib **171***a* and the second protruding rib **172***a*, the outlet **230** of the nozzle **200** faces the first channel **524**, when the switch **162***a* is located between the second protruding rib **172***a* and the third protruding rib **173***a*, the outlet **230** of the nozzle **200** faces the second channel **523**, when the switch **162***a* is located between the third protruding rib **173***a* and the fourth protruding rib **174***a*, the outlet **230** of the nozzle **200** faces the third channel **522**, and when the switch **162***a* is located between the fourth protruding rib **174***a* and the fifth protruding rib **175***a*, the outlet **230** of the nozzle **200** faces the fourth channel **521**.

The switch **162***a* contacts the cam **170***a*. When the cam **170***a* is rotated in the counterclockwise direction and the switch **162***a* is pressed by the protruding ribs **171***a*, **172***a*, **173***a*, **174***a* and **175***a*, the switch **162***a* generates a signal '**0**', and when the switch **162***a* is located between the protruding ribs **171***a*, **172***a*, **173***a*, **174***a* and **175***a*, the switch **162***a* generates a signal '**1**'.

As shown in FIG. **7**B, a section D**11** in which the signal '**1**' is continuously generated and then the signal '**0**' is initially generated corresponds to a position where the first protruding rib **171***a* presses the switch **162***a* in such a manner, a position where the second protruding rib **172***a* is adjacent to the switch **162***a* corresponds to a section D**13** in which the signal '**0**' is secondarily generated, a position where the third protruding rib **173***a* is adjacent to the switch **162***a* corresponds to a section D**15** in which the signal '**0**' is thirdly generated, a position where the fourth protruding rib **174***a* is adjacent to the switch **162***a* corresponds to a section D**17** in which the signal '**0**' is fourthly generated, and a position where the fifth protruding rib **175***a* is adjacent to the switch **162***a* corresponds to a section D**19** in which the signal '**0**' is fifthly generated.

When the cam main body **176***a* is adjacent to the switch **162***a*, the signal '**1**' is generated for a long time, and thus a position where the cam main body **176***a* is adjacent to the switch **162***a* corresponds to a section D**10**.

As described above, in a stopped state of the cam **170***a*, the resolution value of a degree of rotation of the cam **170***a* is not measured. The signal '**1**' is generated for a long time during rotation of the cam **170***a* and then the signal '**0**' is initially generated (the section D**11**). Thereafter, a point of time when the rotating cam **170***a* faces one direction may be measured by judging the number of times that the signal '**1**' is generated.

Accordingly, prior to start of operation, the cam **170***a* needs to be rotated to the initial position, i.e., the position where the first protruding rib **171***a* presses the switch **162***a*. That is, the stopped cam **170***a* is rotated until the signal '**1**' is generated for a long time and then the signal '**0**' is initially generated.

For example, in order to supply water to the third channel **522** (with reference to FIG. **6**A), the cam **170***a* is disposed so that the switch **162***a* contacts the region between the third protruding rib **173***a* and the fourth protruding rib **174***a*. First, the cam **170***a* is rotated, and thus the signal generated by the switch **162***a* is sensed. When the signal '**1**' is generated for a long time (the section D**10**) and then the signal '**0**' is initially generated, it is judged that the cam **170***a* is located such that the first protruding rib **171***a* corresponding to the initial position is adjacent to the switch **162***a*. Rotation of the cam **170***a* is stopped at a point of time when the signal '**1**' is thirdly sensed starting from rotation of the cam **170***a* at the initial position (the section D**16**). Then, the cam **170***a* is located such that the switch **162***a* contacts the region between the third protruding rib **173***a* and the fourth protruding rib **174***a*, and the outlet **230** (with reference to FIG. **6**A) of the nozzle **200** (with reference to FIG. **6**A) faces the third channel **522** (with reference to FIG. **6**A). Therefore, when water is supplied from the water supply pipe **60**, the water is supplied to the third channel **522** through the nozzle **200**.

FIG. **8**A is a view illustrating a rotation control device of a washing machine in accordance with another embodiment of the present invention, and FIG. **8**B illustrates a graph representing signals transmitted by a switch of the rotation control device of FIG. **8**A.

In order to coincide with the rotating direction of the nozzle in FIGS. **6**A and **6**B, FIG. **8**A illustrates the cam, as seen from the bottom.

As shown in FIG. **8**A, a rotation control device **150***b* includes a cam **170***b* and a PCB assembly **160***b*. The PCB assembly **160***b* includes a PCB **164***b*, and a switch **162***b*.

The cam **170***b* is the same as the cam **170***a* of FIG. **7**A in that the cam **170***b* includes a disc-shaped cam main body **175***b*, but includes four grooves **171***b*, **172***b*, **173***b* and **174***b* other than protruding ribs.

The cam **170***b* and the nozzle **200** are disposed such that when the switch **162***b* contacts the first groove **171***b*, the outlet **230** of the nozzle **200** (with reference to FIG. **2**) faces the first channel **524**, when the switch **162***b* contacts the second groove **172***b*, the outlet **230** faces the second channel **523**, when the switch **162***b* contacts the third groove **173***b*, the outlet **230** faces the third channel **522**, and when the switch **162***b* contacts the fourth groove **174***b*, the outlet **230** faces the fourth channel **521**.

When the cam **170***b* is rotated in the counterclockwise direction and the switch **162***b* contacts the grooves **171***b*,

172*b*, 173*b* and 174*b*, the switch 162*b* generates a signal '1', and when the cam 170*a* is located at other positions, the switch 162*b* generates a signal '0'.

As shown in FIG. 8B, a section D21 in which the signal '1' is initially generated corresponds to a position where the switch 162*b* contacts the first groove 171*b*. In such a manner, a position where the switch 162*b* contacts the second groove 172*b* corresponds to a section D23 in which the signal '1' is secondarily generated, a position where the switch 162*b* contacts the third groove 173*b* corresponds to a section D25 in which the signal '1' is thirdly generated, and a position where the switch 162*b* contacts the fourth groove 174*b* corresponds to a section D27 in which the signal '1' is fourthly generated. A position where the switch 162*b* contacts the cam main body 175*b* corresponds to a section D20 in which the signal '0' is generated for a long time, and when the switch 162*b* passes by the section D20, the switch 162*b* again enters the section D21.

In the same manner as the embodiment of FIGS. 7A and 7B, in this embodiment, only relative positions of other positions with respect to the initial position (the section D21) may be detected. Accordingly, prior to start of operation, the cam 170*b* needs to be rotated to the initial position (the section D21).

Such rotation is the same as that in the embodiment of FIGS. 7A and 7B, and a detailed description thereof will thus be omitted.

FIG. 9A is a view illustrating a rotation control device of a washing machine in accordance with a further embodiment of the present invention, and FIG. 9B illustrates graphs representing signals transmitted by switches of the rotation control device of FIG. 9A.

In order to coincide with the rotating direction of the nozzle in FIGS. 6A and 6B, FIG. 9A illustrates the cam, as seen from the bottom.

As shown in FIG. 9A, a rotation control device 150*c* includes a first cam 170*c*, a second cam 170*d*, and two PCB assemblies 160*c* and 160*d* corresponding to the respective cams 170*c* and 170*d*.

The first PCB assembly 160*c* includes a PCB 164*c*, and a first switch 162*c* mounted on one surface of the PCB 164*c* to contact the first cam 170*c*.

The second PCB assembly 160*d* includes a PCB 164*d*, and a second switch 162*d* mounted on one surface of the PCB 164*d* to contact the second cam 170*d*.

The first cam 170*c* includes a disc-shaped first cam main body 173*c*, and a first groove 171*c* and a second groove 172*c* formed on the first cam main body 173*c*.

The second cam 170*d* includes a disc-shaped second cam main body 173*d*, and a third groove 171*d* formed on the second cam main body 173*d*.

The first cam 170*c* and the second cam 170*d* are connected to each other and are rotated together.

In FIG. 9B, the upper graph illustrates signals generated by the first switch 170*c*, and the lower graph illustrates signals generated by the second switch 170*d*.

When the cams 170*d* and 170*d* are rotated in the counterclockwise direction and the switches 162*c* and 162*d* contact the grooves 171*c*, 172*c* and 171*d*, the switches 162*c* and 162*d* generate a signal '1', and when the cams 170*d* and 170*d* are located at other positions, the switches 162*c* and 162*d* generate a signal '0'.

If the first cam 170*c* and the second cam 170*d* are disposed, as shown in FIG. 9A, four positions may be defined.

A first position corresponds to the case in which the first switch 162*c* contacts the first groove 171*c* and the second switch 162*d* contacts the third groove 171*d*, as shown in FIG. 9A. At the first position, both the first switch 162*c* and the second switch 162*d* generate the signal '1'. That is, the first position may be expressed as [1,1].

A second position corresponds to the case in which the first switch 162*c* contacts a region between the first groove 171*c* and the second groove 172*c* and the second switch 162*d* contacts the third groove 171*d*. At the second position, the first switch 162*c* generates the signal '0' and the second switch 162*d* generates the signal '1'. That is, the second position may be expressed as [0,1].

A third position corresponds to the case in which the first switch 162*c* contacts the second groove 172*c* and the second switch 162*d* contacts the second cam main body 172*d*. At the third position, the first switch 162*c* generates the signal '1' and the second switch 162*d* generates the signal '0'. That is, the third position may be expressed as [1,0].

A fourth position corresponds to the case in which the first switch 162*c* contacts the first cam main body 173*c* and the second switch 162*d* contacts the second cam main body 172*d*. At the fourth position, both the first switch 162*c* and the second switch 162*d* generate the signal '0'. That is, the fourth position may be expressed as [0,0].

That is, differently from the above-described embodiments, in this embodiment, pairs of signals generated at the four positions are defined so that the current direction of the nozzle 200 (with reference to FIG. 2) connected to the cams 170*c* and 170*d* may be precisely measured.

Therefore, rotation of the nozzle 200 (with reference to FIG. 2) may be controlled by disposing the cams 170*c* and 170*d* so as to allow the nozzle 200 to face a designated direction at each of the respective positions.

Although the embodiments describe the configuration and operation of the water supply apparatus as being applied the drum washing machine, the configuration and operation of the water supply apparatus may be applied to other washing machines including a pulsator washing machine.

As is apparent from the above description, a water supply apparatus in accordance with one embodiment of the present invention reduces the number of water supply hoses using a rotatable nozzle, thereby simplifying the structure of the water supply apparatus.

The water supply apparatus reduces the size of a detergent supply apparatus, thereby reducing a space within a washing machine.

The water supply apparatus using the nozzle supplies warm water and cold water to all of plural channels through a simple structure.

Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A water supply apparatus usable in a washing machine, which has a drum to accommodate laundry and a detergent supply apparatus including a dispenser provided with a plurality of channels to supply water to a plurality of detergents to be supplied to the drum, comprising:

at least one water supply pipe extending from the rear portion of the washing machine to the detergent supply apparatus to supply water to the dispenser;

a nozzle provided with one end connected to the at least one water supply pipe and the other end disposed

adjacent to entrances of the plurality of channels, and being rotatable to supply water selectively to one of the plurality of channels;

a drive unit generating drive force to rotate the nozzle; and

a rotation control device to control rotation of the drive unit,

wherein the nozzle includes:

one inlet provided adjacent to the at least one water supply pipe such that water is introduced into the nozzle through the inlet; and

one outlet to supply water to one of the plurality of channels,

wherein the inlet has an area sufficient to cover one end of the at least one water supply pipe so as to allow water supplied from the at least one water supply pipe to be introduced into the nozzle through the inlet, and

wherein the rotation control device includes:

a cam connected to the drive unit to be rotated together with the drive unit, and including at least two positioning indicators, and

a switch disposed to be activated by each of the at least two positioning indicators as the nozzle is rotated, to determine a rotation position of the nozzle.

2. The water supply apparatus according to claim **1**, wherein the outlet has a smaller area than the entrances of the plurality of channels to supply water to one of the plurality of channels.

3. The water supply apparatus according to claim **1**, wherein the inlet has a greater area than the outlet.

4. The water supply apparatus according to claim **3**, wherein:

the nozzle includes nozzle side walls forming both side surfaces of the inlet and the outlet; and

the nozzle side walls are formed in a curved line from the inlet to the outlet.

5. The water supply apparatus according to claim **1**, wherein the drive unit includes a motor.

6. The water supply apparatus according to claim **5**, wherein the drive unit further includes a plurality of gears disposed between the motor and the nozzle to transmit drive force of the motor to the nozzle.

7. The water supply apparatus according to claim **6**, wherein the plurality of gears includes:

a first gear connected to the nozzle and rotated together with the nozzle; and

a second gear connected to the motor and rotated by drive force of the motor.

8. The water supply apparatus according to claim **1**, wherein:

the nozzle is rotatably accommodated in the detergent supply apparatus; and

the drive unit is disposed on the upper surface of the detergent supply apparatus.

9. The water supply apparatus according to claim **1**, wherein the

cam includes at least one protruding rib protruding in the centrifugal direction; and

the switch is disposed to contact the cam, and locked with and unlocked from the at least one protruding rib to generate an ON signal and an OFF signal when the cam is rotated.

10. The water supply apparatus according to claim **1**, wherein the

cam includes at least one groove disposed in the radial direction; and

the switch is disposed to contact the cam, and locked with and unlocked from the at least one groove to generate an ON signal and an OFF signal when the cam is rotated.

11. A water supply apparatus usable in a washing machine, which has a drum to accommodate laundry and a detergent supply apparatus to supply detergents to wash water supplied to the drum, comprising:

at least one water supply pipe extending from the rear portion of the washing machine to the detergent supply apparatus to supply water to the detergent supply apparatus; and

a nozzle provided with one end connected to the at least one water supply pipe and the other end disposed to supply water to the detergent supply apparatus, and being rotatable to supply water in a designated direction within the detergent supply apparatus;

a cam connected to the nozzle to be rotated together with the nozzle, and including at least two positioning indicators; and

a switch disposed to be activated by each of the at least two positioning indicators as the nozzle is rotated, to determine a rotation position of the nozzle,

wherein the nozzle includes:

one inlet provided adjacent to the at least one water supply pipe such that water is introduced into the nozzle through the inlet; and

one outlet to supply water to one of the plurality of channels,

wherein the inlet has an area sufficient to cover one end of the at least one water supply pipe so as to allow water supplied from the at least one water supply pipe to be introduced into the nozzle through the inlet.

12. The water supply apparatus according to claim **11**, wherein:

the detergent supply apparatus includes a dispenser provided with a plurality of channels to respectively supply water to a plurality of detergents; and

the nozzle is rotatable to respectively supply water to the plurality of channels.

13. The water supply apparatus according to claim **12**, wherein:

the detergent supply apparatus further includes a detergent case forming the external appearance of the detergent supply apparatus and accommodating the dispenser; and

the nozzle is rotatably fixed within the detergent case.

14. The water supply apparatus according to claim **11**, further comprising a drive unit connected to the nozzle to rotate the nozzle.

15. The water supply apparatus according to claim **14**, further comprising a rotation control device to control rotation of the drive unit to stop the nozzle in a designated direction to supply water.

* * * * *